



# USGS Agency Report

Tom Cecere

Land Remote Sensing Program

703-648-5551

[tcecere@usgs.gov](mailto:tcecere@usgs.gov)

ICCAGRA

Tampa, FL

November 9, 2009

U.S. Department of the Interior  
U.S. Geological Survey

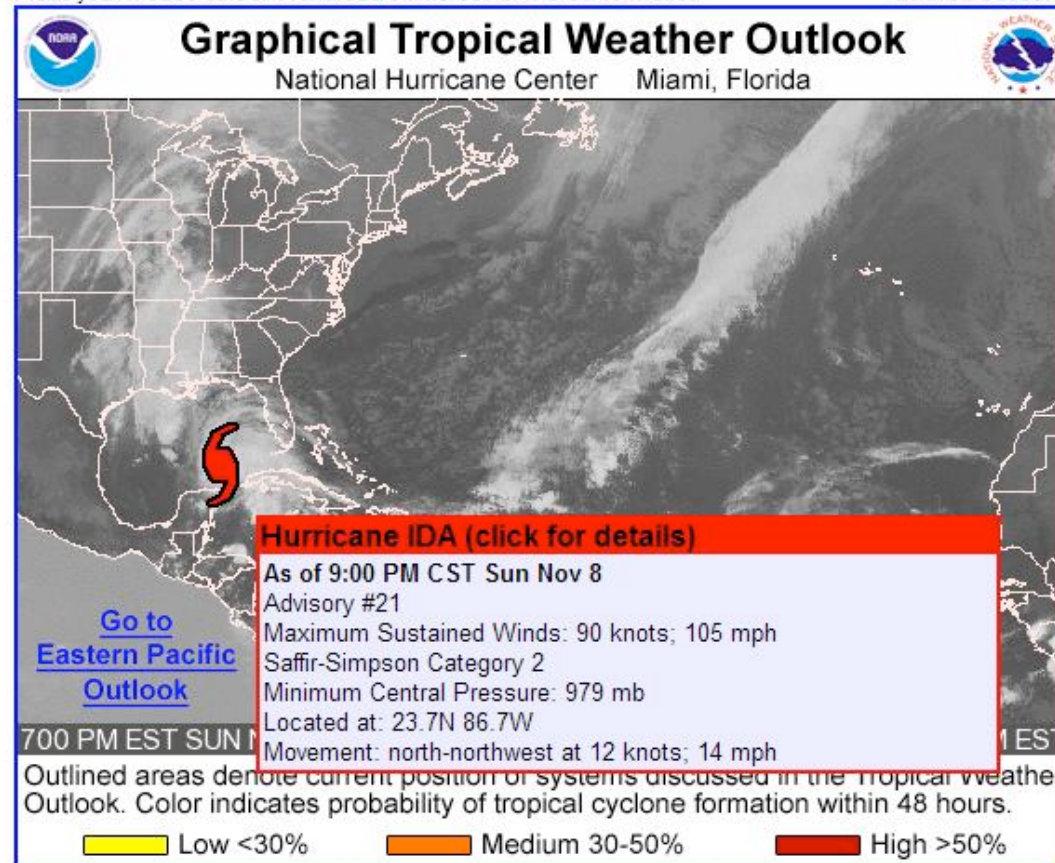
# Hurricane IDA

## Atlantic Graphical Tropical Weather Outlook

This product is updated at approximately 1 AM, 7 AM, 1 PM, and 7 PM EST from June 1 to November 30. Special outlooks may be issued as conditions warrant.

Place your mouse cursor over areas of interest for more information

[Archived Outlooks](#)







# Existing and Potential Applications of the USGS Experimental Advanced Airborne Lidar (EAARL)

***John Brock***

***USGS Geologic Discipline, Coastal and Marine Geology Program,  
Reston, VA [jbrock@usgs.gov](mailto:jbrock@usgs.gov)***



# The USGS/AM Pilatus PC-6

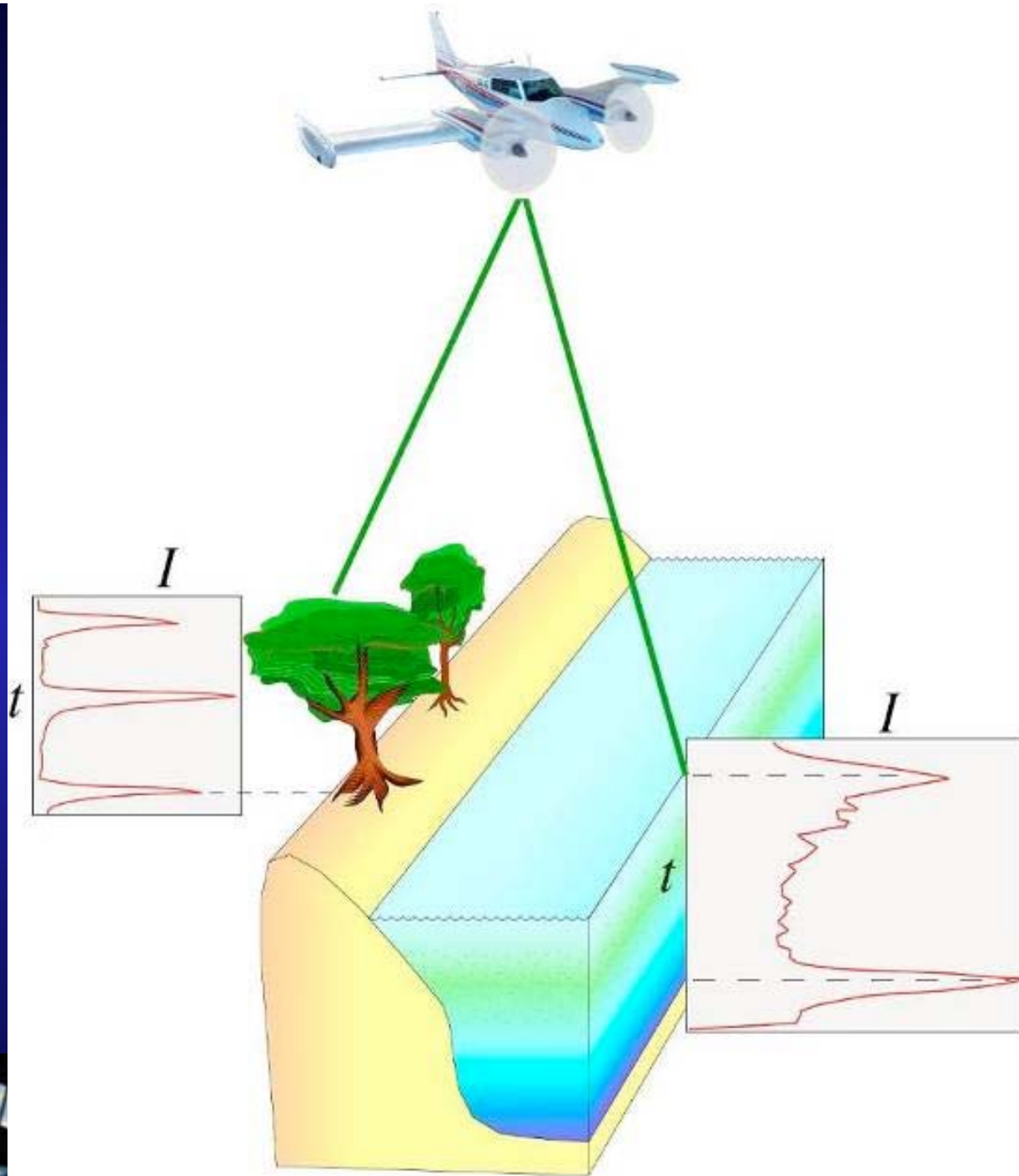
- Owned by the USGS
- Likely the first DOI/AM approved EAARL aircraft
- Unused past 3-4 years
- Denver, Co.
- High Altitude (28k)
- Unimproved runways
- Slow survey speed (65 kts)
- Turbo Prop engine
- Existing down looking port
- Large cargo doors
- Slow transit speed (110 Kts)
- Primarily for mountain operations too high for twin Cessna 310.
- Have USDA/FS project to Fraser Forest in Roanoke Mountains





# Experimental Advanced Airborne Research Lidar (EAARL) PI: Wayne Wright, USGS

- Cross environment  
topo/bathy capabilities
- Small-footprint,  
waveform-resolving,  
green-wavelength lidar
- Detailed topography of  
shallow marine substrates  
& vegetation canopies
- Digital multi-spectral  
imagery (RGB and CIR)



# Existing EAARL Applications:

Baseline coral reef geomorphology

Coral reef ecology

Coral reef genesis and sea level rise

SLR and coastal inundation forecasts

Coastal change hazards

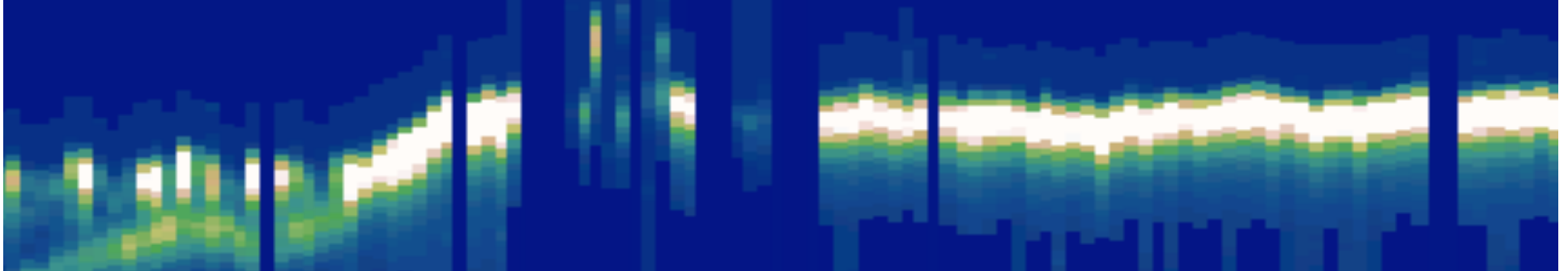
Mapping depositional environments

Vegetation canopy mapping

Wetland vegetation mapping

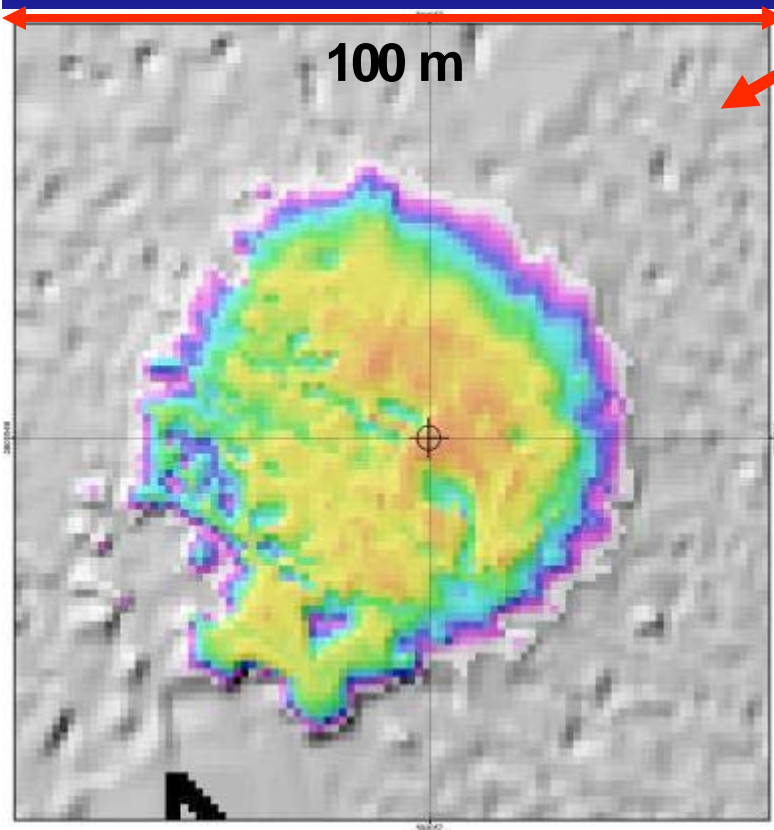
Wetland hydrology

Fluvial channel mapping





# Coral Reef Genesis and Sea Level Rise – John Brock

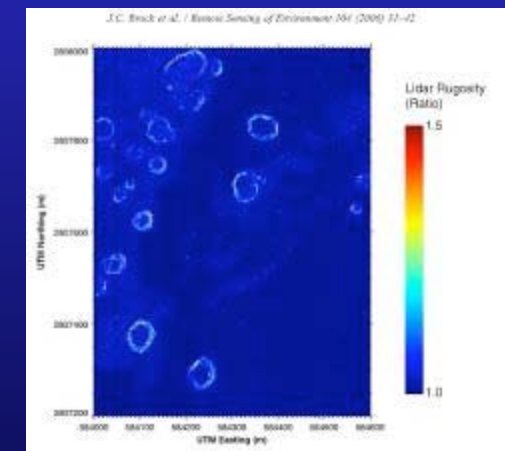
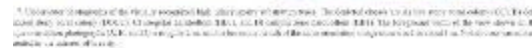


Biscayne National Park





# John Brock



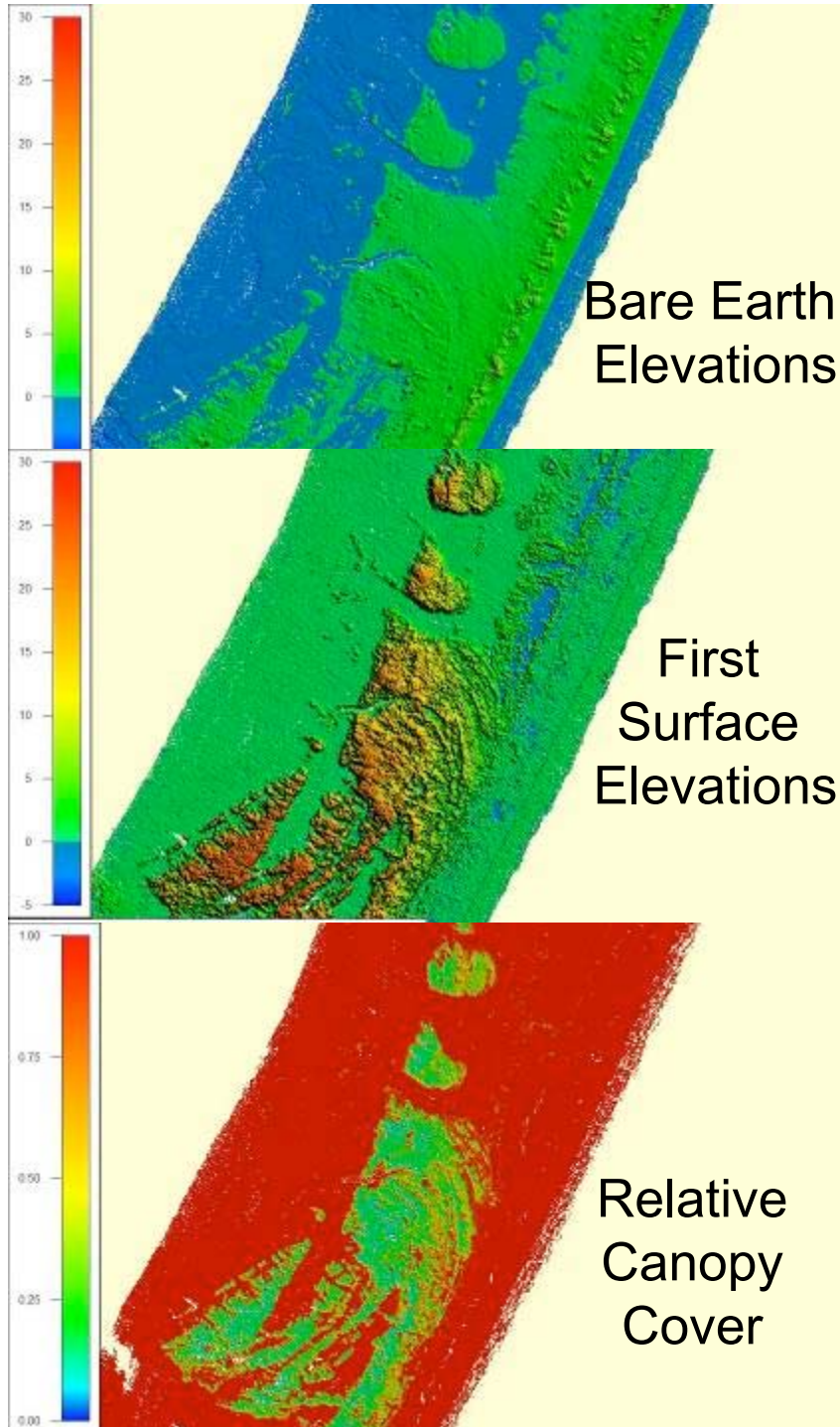


# Vegetation Canopy Mapping and Classification:

Amar Nayegandhi, Monica Palaseanu

**Unsupervised  
classification  
in GIS  
software**

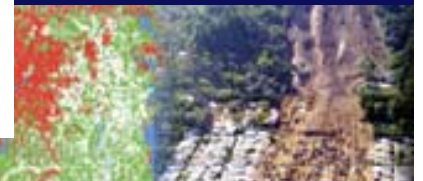
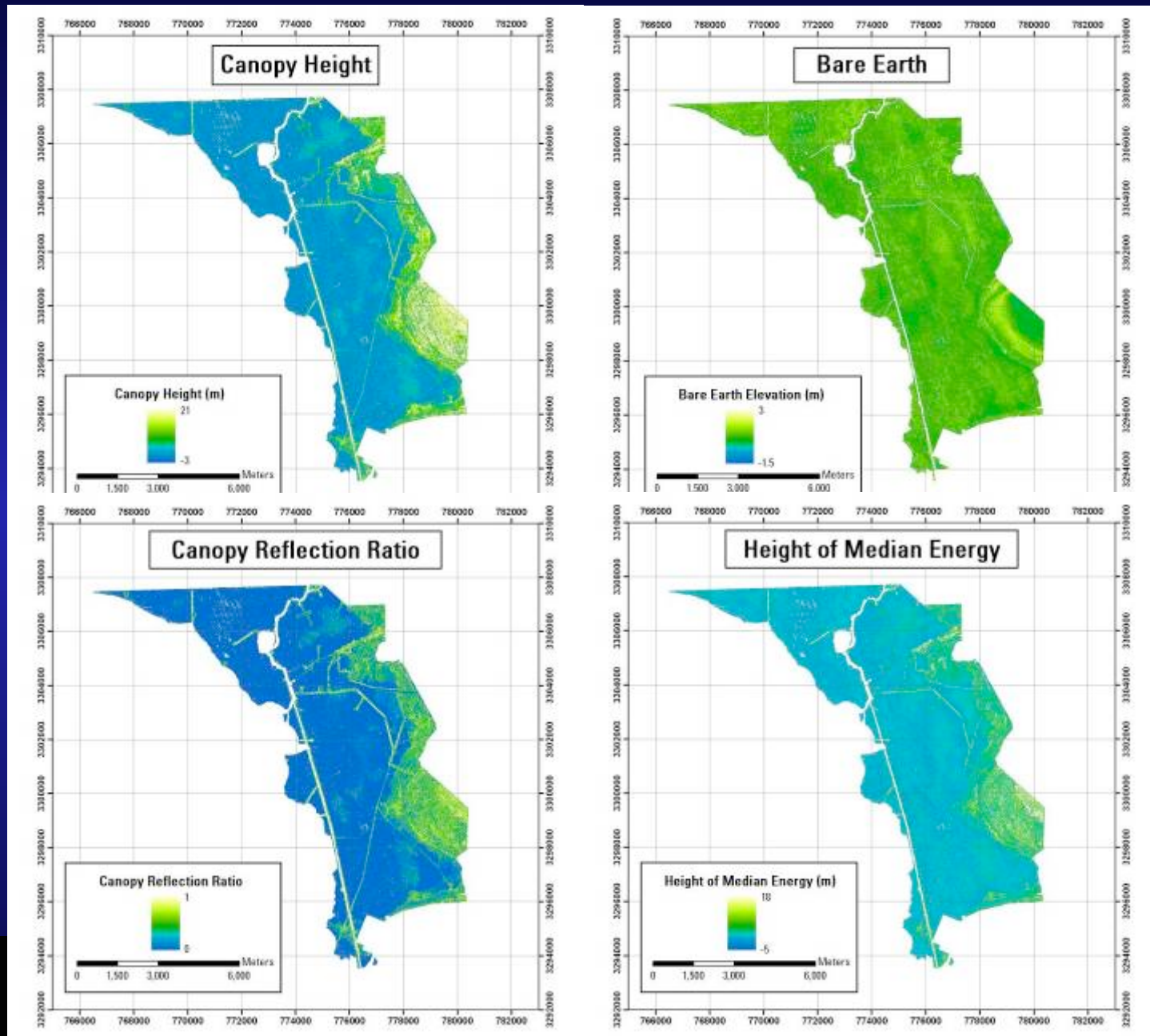
**Classification  
map**



## Legend

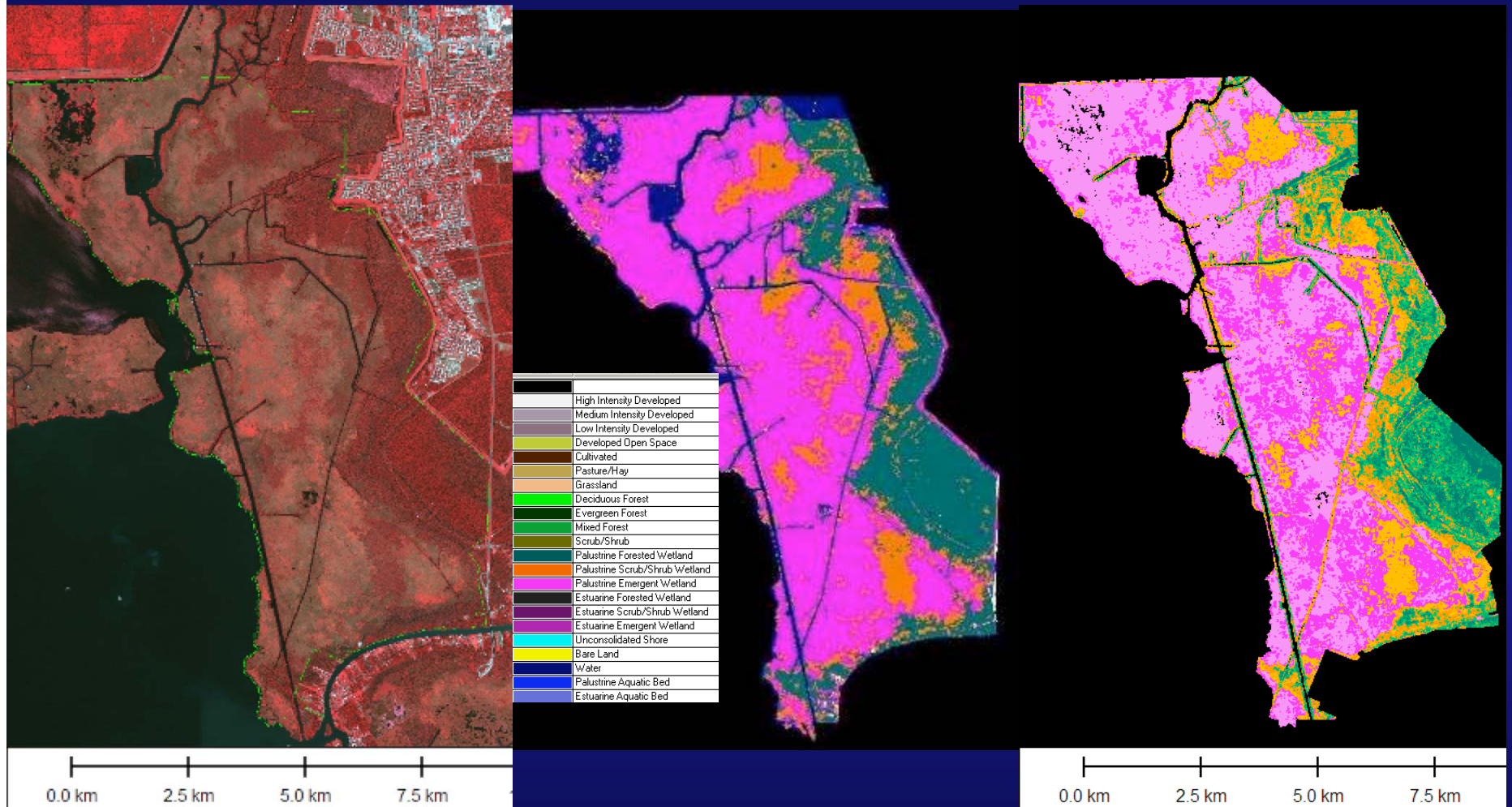
- Sand
- Dune Sand/Veg
- Upland Grass
- Wet Herbaceous
- Marsh
- Salt Scrub
- Shrub
- Mixed Shrub/Dunes
- Tall Shrub
- Woodland
- Forest

# Jean Lafitte National Park (JELA ) EAARL vegetation metrics:





# Comparing lidar-derived vegetation structure delineation with high-resolution land cover classification



CIR Imagery

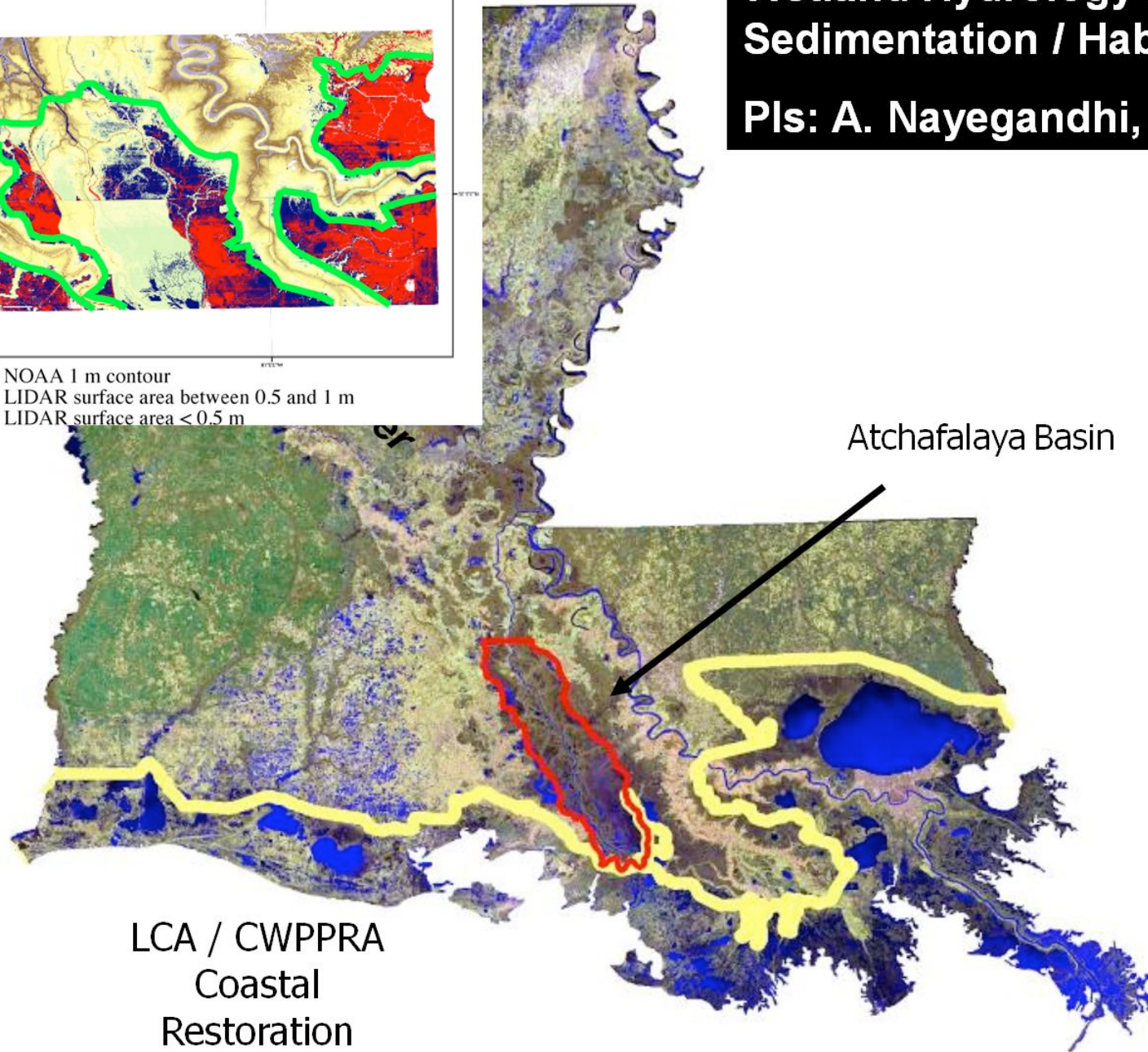
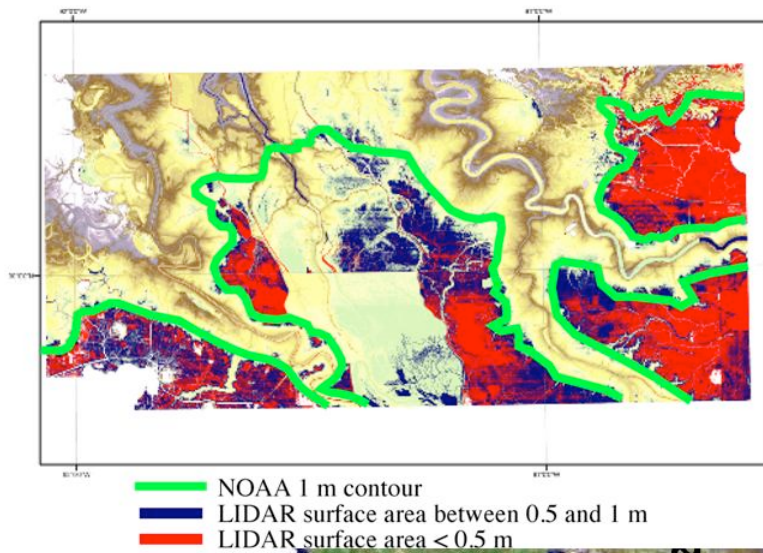
Quickbird 2006  
Classification

Lidar-derived Vegetation  
Delineation



# Wetland Hydrology / Sedimentation / Habitats+

PIs: A. Nayegandhi, D. Gesch







# Fluvial Channel Mapping

(Hydrology, Fluvial Processes, Habitats)

PI: James McKean

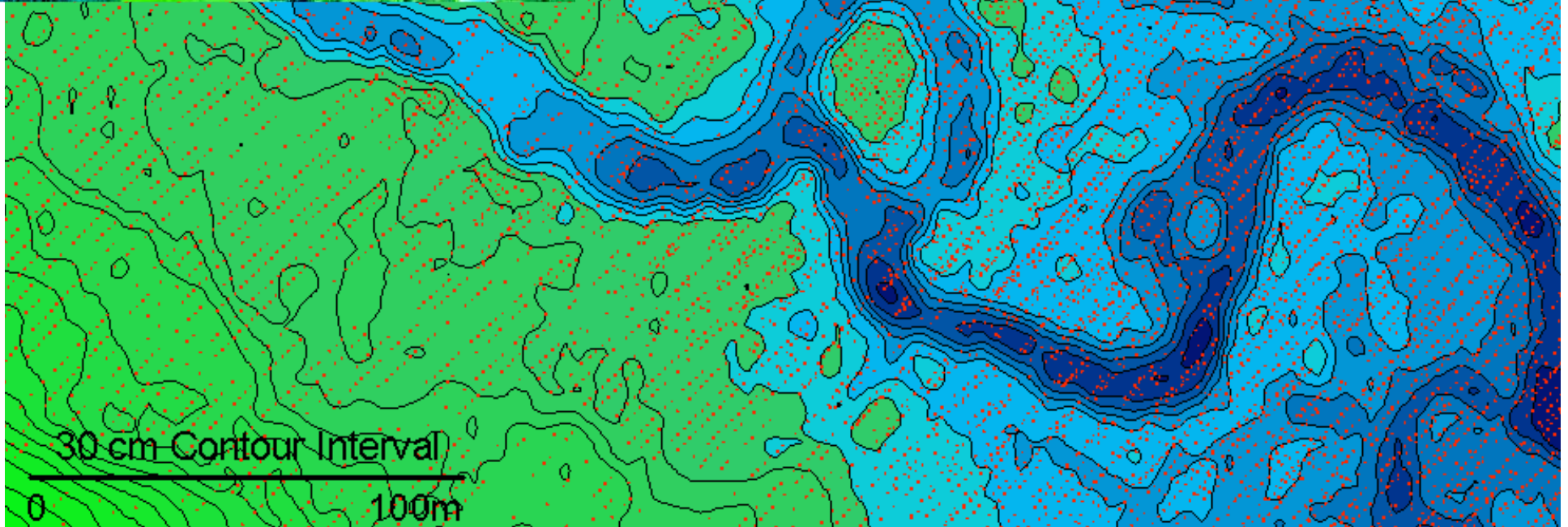


Image courtesy Jim McKean, USDA Forest Service

# EAARL Update

- **Recent Activities**
  - Survey S. Atchafalaya Basin in November
- **Upcoming Missions**
  - Mountain Stream Mapping - TBD
  - AK North Slope
- **Replacement Laser funded**
  - Scanning configuration change leading to improved capabilities



# UAS Issues presented Oct 2008

- **FAA COA and associated regulations**
- **Operator Training**
- **Defining UAS classes**
- **Procurement Vehicle Establishment**
  - Purchase or lease?
  - Contract for data?
- **Sensor Development**
  - Currently available: SAR, IR, FMV, LIDAR, MS, HyperSpectral
  - Sensor vs. Platform
- **Dissemination/Archiving of Data**
- **Analysis of Data**
  - Right Tools?
  - FMV
- **USGS UAS Roadmap to be developed this FY**





# UAS Challenges:

## Safety Issues:

- Ensure the safety of the NAS
- Spectrum (communications)
- COA process
- Operator- Pilot Certification

## Scientific Investigations/ Incident Response:

- Integration with other capabilities
- Authoritative analysis of data
- Archive responsibilities

## Cost of UAS missions:

- Aligned with manned missions
- Value- demonstrate greater scientific value than manned operations

## Outreach- Training:

- Management Awareness
- "ist" Awareness

No focal point existed in USGS  
(or DOI) related to UAS technology





# **Boldly Going Where No Man (or Woman) Goes: USGS**

**Unmanned Aircraft- USGS Press Release May 8, 2008**

**Lead and coordinate the USGS efforts to promote and develop UAS technology for civil agency, domestic applications:**

- **Evaluate and conduct feasibility tests of UAS related technology**
- **Support and document UAS user application developments**
- **Influence budget requests, plans and allocations**
- **Provide an overview of the current state of platforms and sensors**
- **Document technologies necessary to support future missions**
- **Document requirements based on user-defined needs.**
- **Engage collaborators and develop strategic partnerships**





# U.S. Geological Survey UAS Roadmap

**USGS is working with DoI partners, NASA, NOAA, academia and private industry to assess the capabilities of Unmanned Aircraft Systems for civil use. A key part of this activity is to develop a report that will serve as a roadmap for the development of these applications. The report will :**

- **Determine and document potential civil missions for UAS technology based on user-defined needs.**
- **Determine and document the technologies necessary to support those missions.**
- **Discuss the present state of the UAS capabilities and related technologies; identifying those in progress, those planned, and those for which no current plans exist.**
- **Serve as the foundation for USGS UAS related budget proposals**
- **Provide the foundation for a comprehensive civil UAV roadmap.**





# Current State



 **USGS**





# Raven System Description

**Provides USGS and our partners with an enterprise level , low cost, low risk UAS capability to “cut our teeth”**

**Operator training and certification**

**Establish air worthiness inspection criteria**

**Develop user applications and standard operation procedures**

**GAP Analysis- sensors, platforms**



## Description

Wing Span	4.5 ft
Air Vehicle Weight	4 lbs
Range	10+ km (LOS)
Airspeed	27-60 mph
Altitude	>300 AGL
Endurance	90 min Lithium
Payload	<ul style="list-style-type: none"><li>- Improved Day Camera – wider field of view, increased resolution, 3X Zoom, Ethernet, National Television Standard Compliant (NTSC)</li><li>- External Interfaces</li><li>- IR with Laser Illuminator –25 ft spot marking capability</li></ul>
GCS/RVT	<ul style="list-style-type: none"><li>- Combined Weight – 14 lbs</li></ul>

## Characteristics

- Rapidly deployed
- Decentralized planning and execution
- Cost effective
- Easily transportable

## Raven Operational Mission Sets

- Remote reconnaissance and surveillance
- Damage assessment
- Resource inventory Support

## Benefits/Capabilities

**Provides enhanced situational awareness by providing expanded reconnaissance and surveillance coverage.**

- Hand-launched
- GPS
- Semi-autonomous operations and in-flight retaking
- Commanded auto-loiter at sensor point of interest
- Executes lost link recovery procedures



# Sensor Packages:

- Mapping Cameras
- Multispectral
- Thermal- Infrared
- LiDAR
- Hyperspectral
- Radars (SAR, InSAR, IfSAR)
- Full Motion Video
- Chemical/ Gas





# Way Forward-

## Collaboration / Collaboration/ Collaboration

- Identify common goals/ missions
- Improve communications, particularly concerning civil applications
- Pool assets and leverage resources
- Identify performance measurements, platforms and sensors
- Develop Formal Agreements (military, civil, private industry, academia)
- Assist the FAA in refining its UAS operating plans and procedures



 USGS





# Key Partnerships/ Collaboration:

- International Society of Photogrammetric and Remote Sensing (ISPRS) Commission 1, UAS Working Group
- International Society of Remote Sensing for the Environment (ISRSE)
- The Association for Unmanned Vehicle Systems International (AUVSI)
- National Science Foundation (NSF), Federal Aviation Administration (FAA), Department of Homeland Security, (DHS), and AUVSI UAS working group
- American Association of Aeronautics and Astronautics (AIAA)
- USNORTHCOM UAS Working Group
- Interagency Coordinating Committee for Airborne Geoscience Research and Applications (ICCAGRA) UAS working group
- NOAA, NASA, FAA, DoD, Army UAS Program Offices
- National Guard Bureau (U.S. Army UAS War fighters Round Table)
- Department of the Interior Remote Sensing Working Group (DOIRWG)
- DOI Aviation Management Directorate
- Tactical Fire Remote Sensing Advisory Committee (TFRSAC)
- New Mexico State University, University of Colorado, Air Force Academy, University of Idaho, Utah State University, University of Alaska- Fairbanks, Massachusetts Institute of Technology, University of Florida





# Summary

**Much like Global Positioning System and Internet technology have changed the way we do business- Unmanned Aircraft Systems will transform the methods and techniques employed across the Department of the Interior and the United States Geological Survey to conduct our missions. Cost effective UAS technology is currently available to support a wide variety of applications including:**

- managing federal lands
- monitoring environmental conditions and natural resources use
- analyzing dynamic earth processes
- supporting global and climate change investigations (carbon trade)
- supporting law enforcement actions
- aiding search and rescue teams
- inventory of wildlife
- generating mapping, charting, and geodesy products
- conducting environmental impact assessments
- developing an archive of observations
- preventing, preparing for, responding to, and recovering from disasters

**<http://rmgsc.cr.usgs.gov/UAS/>**





# Project Information

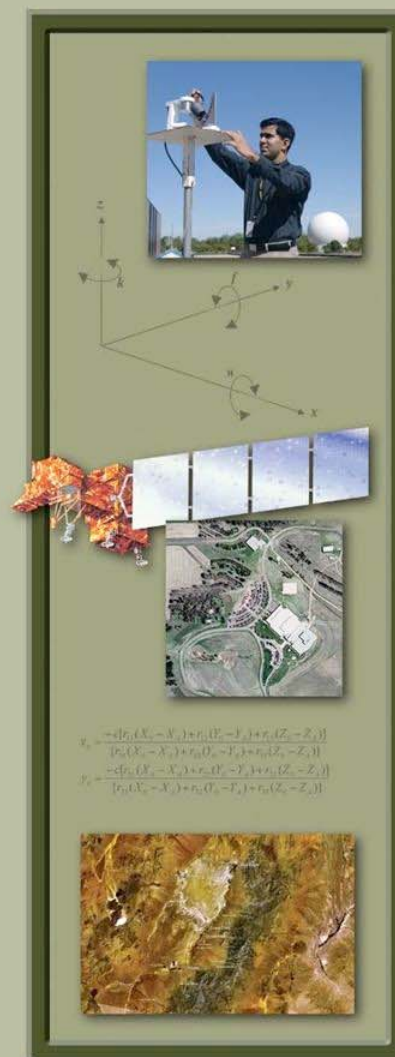
## November 2009

### Remote Sensing Technologies (RST) Project

<http://calval.cr.usgs.gov/>

Greg Stensaas, [stensaas@usgs.gov](mailto:stensaas@usgs.gov)

U.S. Department of the Interior  
U.S. Geological Survey

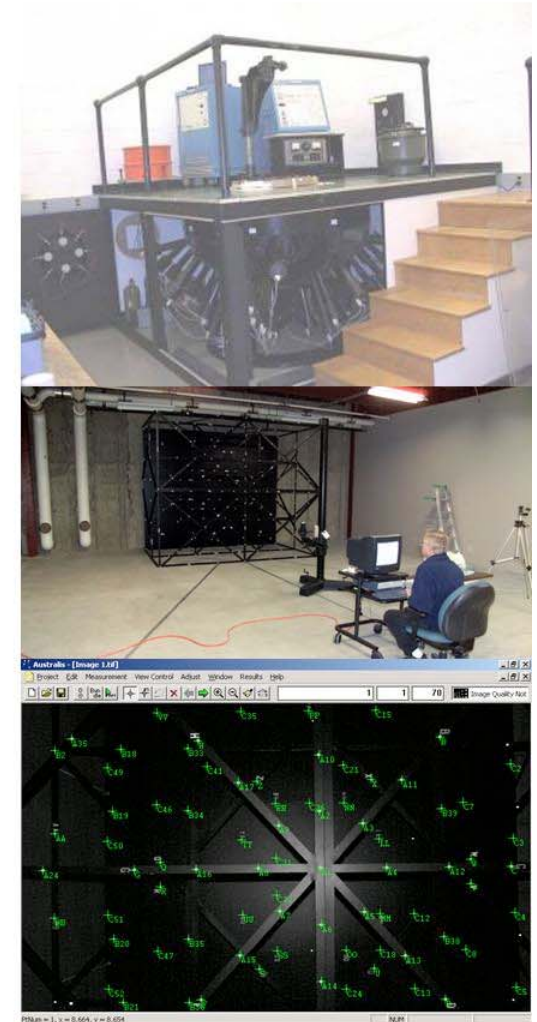






# USGS Calibration, Characterization, and Image Quality Assurance

- **USGS has a strong history of sensor calibration** (Landsat, other Satellites, and Photography)
- **USGS Optical Sciences Lab (OSL)**
  - ◆ Responsible for film camera calibration since '73
  - ◆ 70-90 cameras per year
- **ASPRS panel of experts >> USGS should address digital aerial sensor and satellite calibration processes (2000)**
  - ◆ USGS established an Interagency Digital Imagery Working Group (IADIWG) of 14 agencies
- **U.S. Digital Camera Calibration responsibilities centered at USGS (2002) <http://calval.cr.usgs.gov/>**
  - ◆ Validating Laboratory and *In-Situ* calibration methods
  - ◆ Establishing Calibration Processes and Guidelines
  - ◆ EROS calibration lab has research over 40 systems
  - ◆ Developed USGS Plan for Quality Assurance of Digital Aerial Imagery





# USGS Calibration, Characterization, and Image Quality Assurance

## USGS Plan for Quality Assurance of Digital Aerial Imagery

### • Manufacturer Sensor Type Certification

- ◆ Currently certifying sensors
- ◆ Working with International Partners to establish a common practice

### • Data Provider Product Evaluation

- ◆ Developed Cal & Val Range Stds.
- ◆ Developing 6 National Ranges
- ◆ Dual use for hi-res ortho & satellite, & LiDAR cal/val

### • Image Quality Guidelines and Processes

- ◆ Spec and Check Tool development
- ◆ Contracting and QA guidelines
- ◆ Performance Tracking Tools

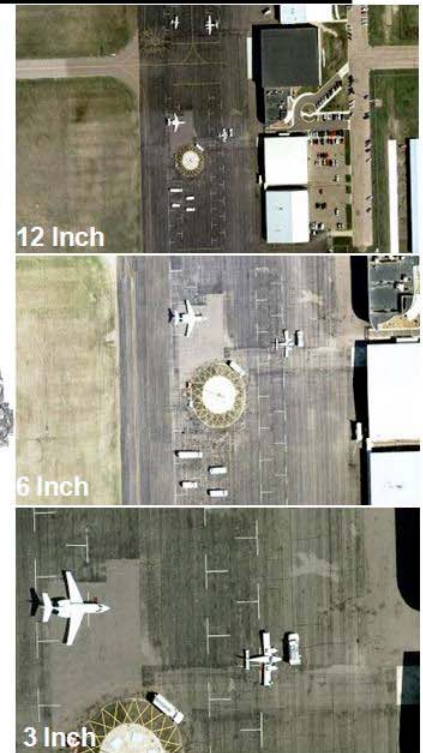
Large area  
Geometric Test  
Range



Spec development and QA check tool



USGS EROS Lidar derived 3D  
image map



USGS Cal/Val Basemap range:  
hi res image and LiDAR data



Geometric Targets and Control





# USGS Calibration, Characterization, and Image Quality Assurance

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- **User community is not sure how to contract for digital imagery**
  - ◆ Technology moving quickly! Need to encourage digital imaging!
  - ◆ New terms, capabilities, standards, lexicon
  - ◆ Inhibits digital contracting
  - ◆ Addresses boilerplate requiring “USGS Certificate of Calibration”
  - ◆ Goal is to remove barriers to digital aerial contracts
  - ◆ Need to get all Government partners standardized!!
- Created Federal Digital Imagery General Contract Guideline
- Developing QA processes and Tools, such as “*Spec and Check*” tool
  - ◆ **Creates user specifications for contracts and provides recommended QA test verification methods**
    - User friendly tool with knowledge data base for ease of training and understanding
  - ◆ **IADIWG continuing to work cal/val processes**
    - LiDAR, thermal, SAR, and integrated systems becoming high priority



# USGS Calibration, Characterization, and Image Quality Assurance

## Manufacturer Sensor Type Certification

- “USGS Certification” required in contracts
  - ◆ US and International system purchase requirement
- Five system types have been certified to date:
  - ◆ Applanix DSS-322, -422, -439
  - ◆ Intergraph Z/I DMC
  - ◆ MS Vexcel UltraCam D, UltraCam X, and UltraCam Xp
  - ◆ Leica: ADS40 w/ SH40, SH52, & SH52
  - ◆ M7 Visual Intelligence

## Data Provider Evaluation

- Revised Process
  - ◆ System and Product evaluation only - Internal QA
  - ◆ Process evaluation dropped from the plan
  - ◆ Use 3”, 6”, 12” resolution base maps and high density LiDAR
  - ◆ Utilize automated assessment tool and “spec and check tool” imagery assessment methods
  - ◆ DP evaluation up to once per year and required within 3 years; reimbursable DP cost ~ \$2500-3000 per evaluation
- Sioux Falls range is a prototype for other five regional ranges
  - ◆ Will be used for high-res satellite characterization also

### Cameras not yet certified:

- |   |   |
|---|---|
| ◆ GeoVantage GeoScanner (in process)                | ◆ Leica ADS80 w/ SH81 & SH82; and RCD105* |
| ◆ Pictometry International (scheduled for December) | ◆ DiMAC                                   |
| ◆ Applanix DSS DualCam                              | ◆ Icaros Geosystems                       |
| ◆ Intergraph RMK D                                  | ◆ A3 Vision Map                           |
| ◆ MS Vexcel UltraCam L and G                        | ◆ Wehrli                                  |
|   | ◆ Rollei                                  |
|   | ◆ Airborne Data Systems                   |
|   | ◆ Jena                                    |
|   | ◆ Optronik                                |
|   | ◆ ...                                     |





# USGS Calibration, Characterization, and Image Quality Assurance

## Joint Agency Commercial Imagery Evaluation (JACIE) 9th Annual Workshop

**Civil Commercial  
Imagery Evaluation  
Workshop**



- **March 16-18, 2010 @ Fairfax Marriott, Fairfax, VA**
  - ◆ Registration information and 8 years of evaluation presentations available @ <http://calval.cr.usgs.gov/jacie.php>
  - ◆ NASA, NGA, NOAA, USGS, USDA Collaboration
  - ◆ Scope covers Satellite & Aerial sensors useful to the remote sensing community – U.S. and International systems
  - ◆ Independent assessment of product quality and usability
  - ◆ Evaluation of remote sensing applications and data



## ARRA Lidar Priority Collection Areas National Elevation Dataset 1/9-Arc-Second Status

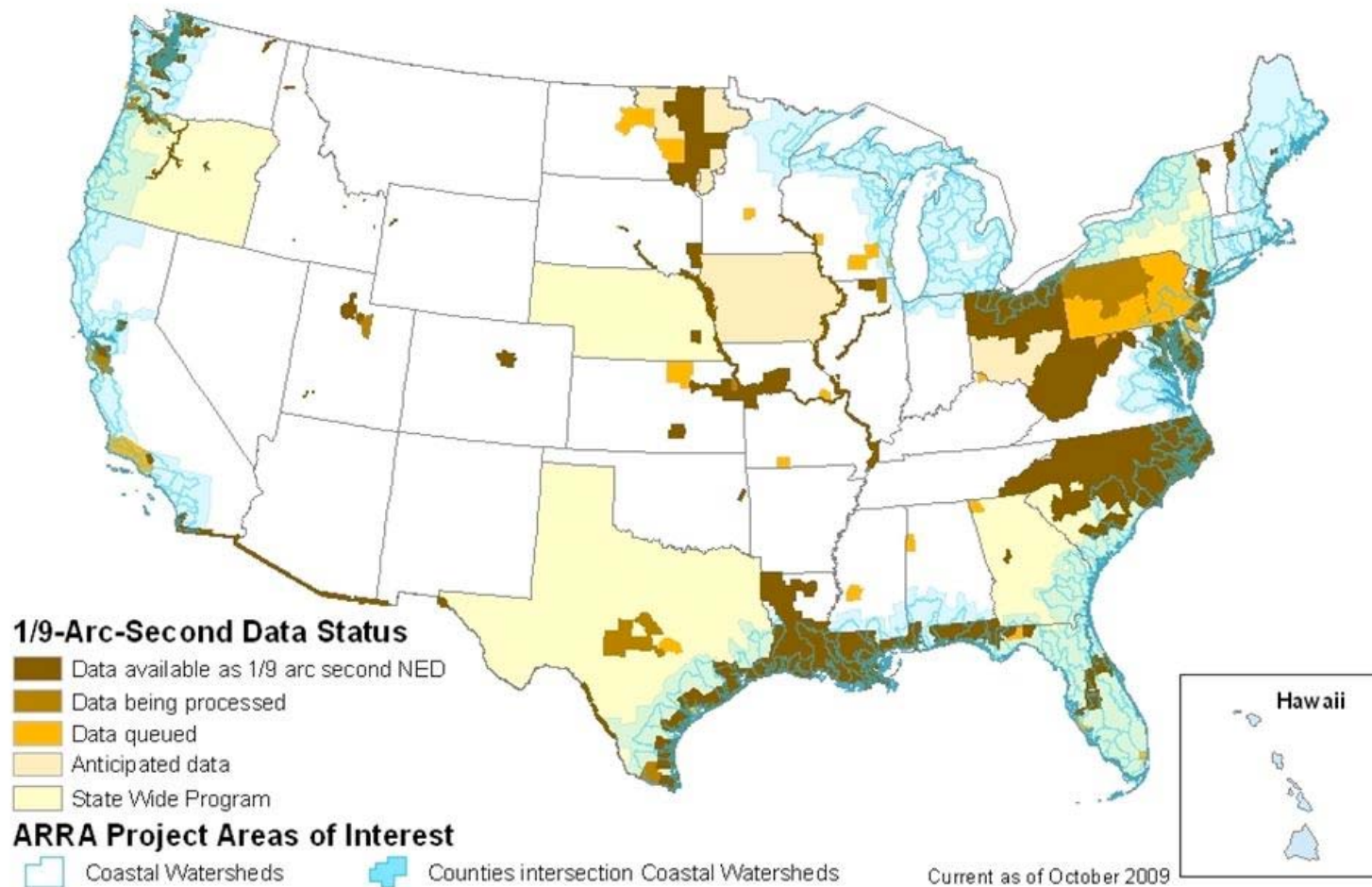


Figure 1. ARRA Lidar Priority Collection Areas include coastal watersheds extended to county boundaries (shown in light blue). Existing and in process data are shaded in other colors.

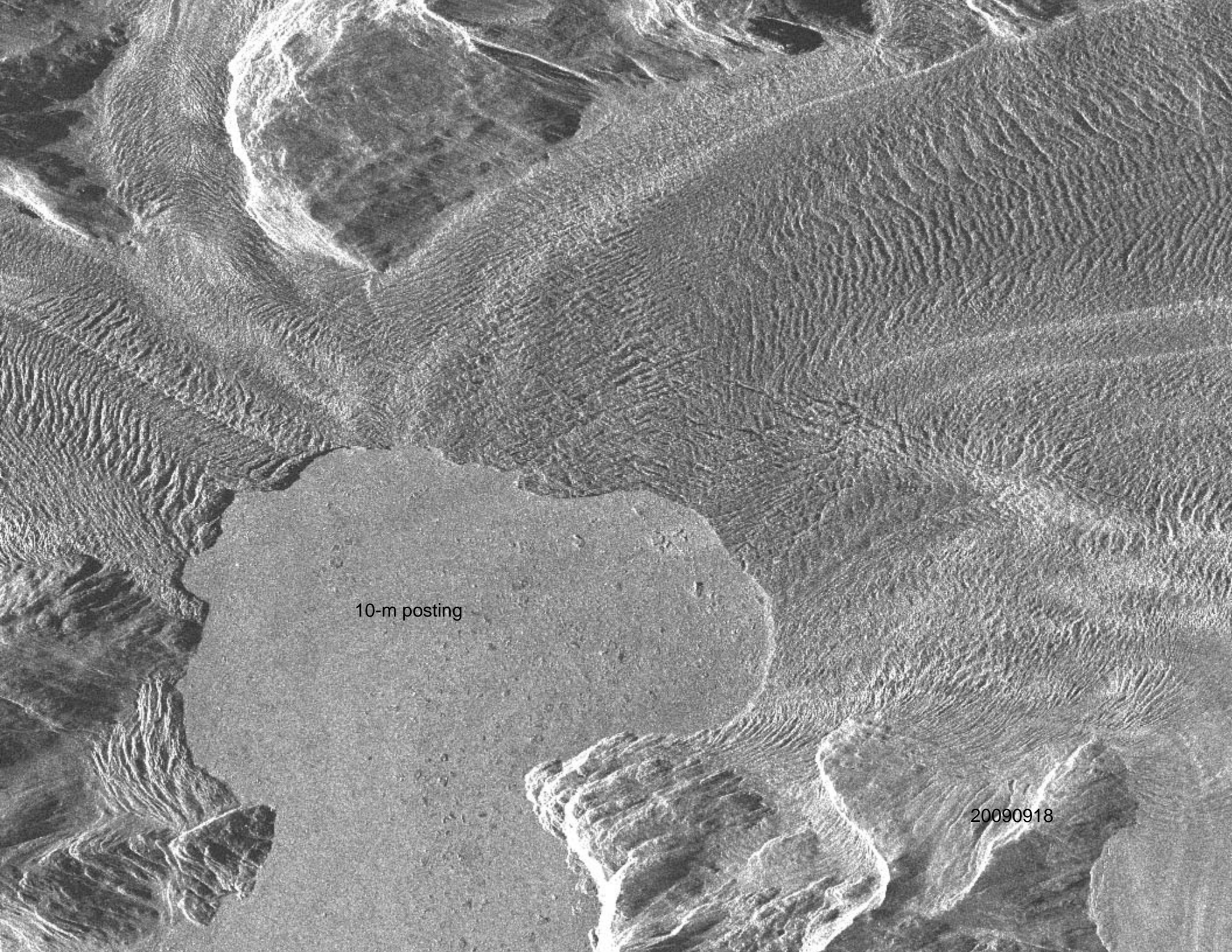




10-m posting

20090907





10-m posting

20090918



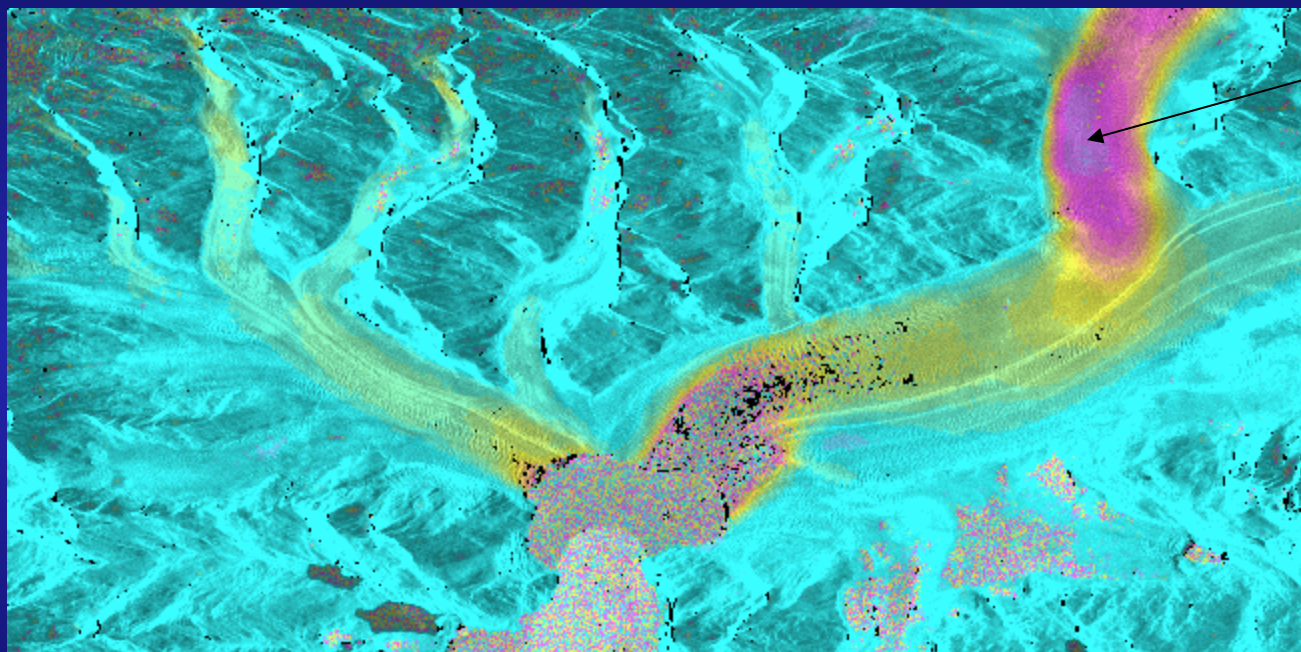


10-m posting

20090929

# Glacier Motion: 20090907-20090918

North-South Displacement

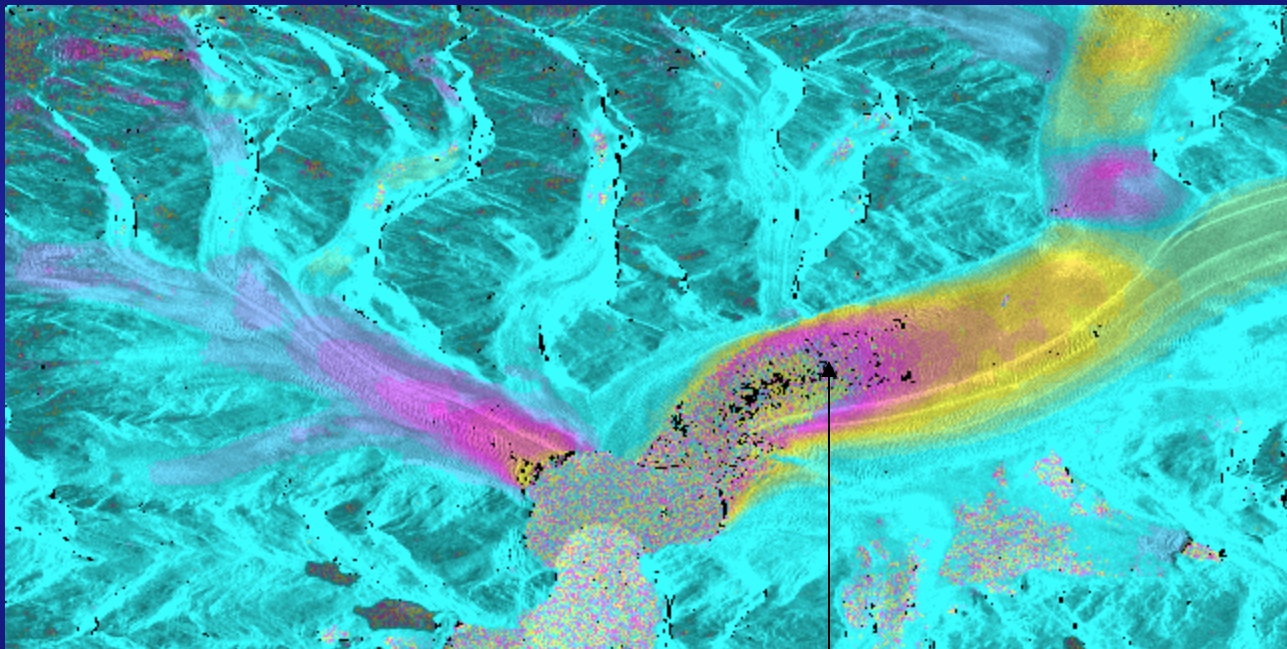


45 m



# Glacier Motion: 20090907-20090918

East-West Displacement



50 m

